PathOpt – network typology optimization tool

Hubs4Circularity Community of Practice Webinar
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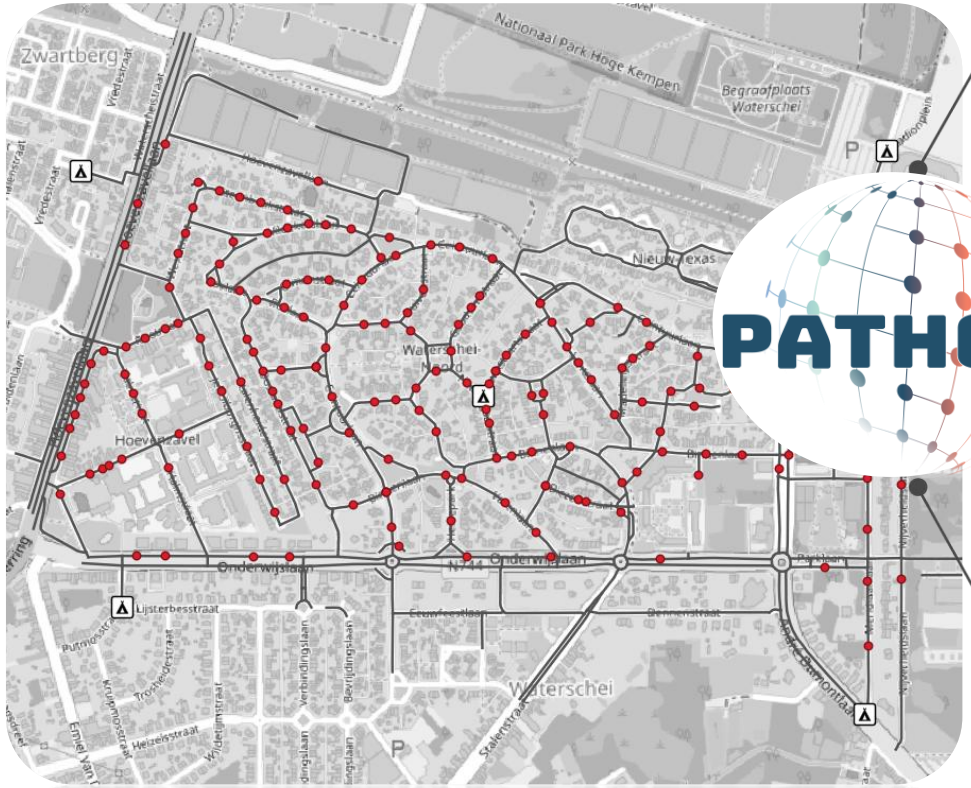
PathOpt – What is it?

Accurate (non-linear Physics)

Fast & Scalable (adjoint-based)



PATHOPT

Optimized Network Layout
Efficient design for minimal cost.

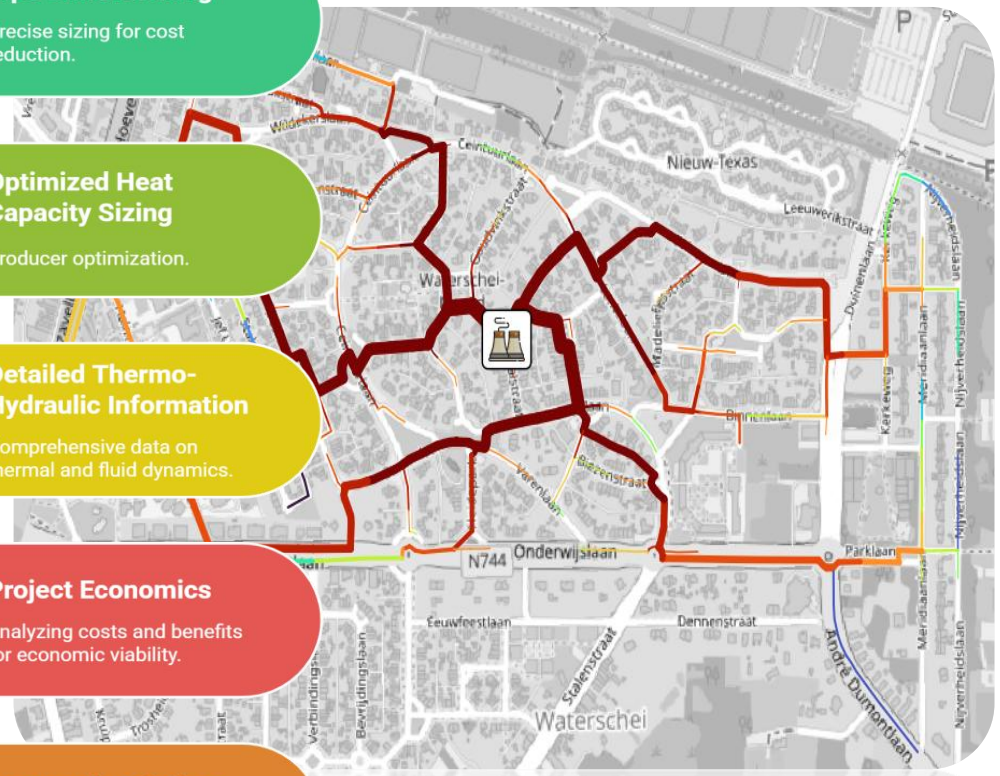
Pipe Dimensioning
Precise sizing for cost reduction.

Optimized Heat Capacity Sizing
Producer optimization.

Detailed Thermo-Hydraulic Information
Comprehensive data on thermal and fluid dynamics.

Project Economics
Analyzing costs and benefits for economic viability.

Seasonal Variations
Understanding and adapting to seasonal heat changes.



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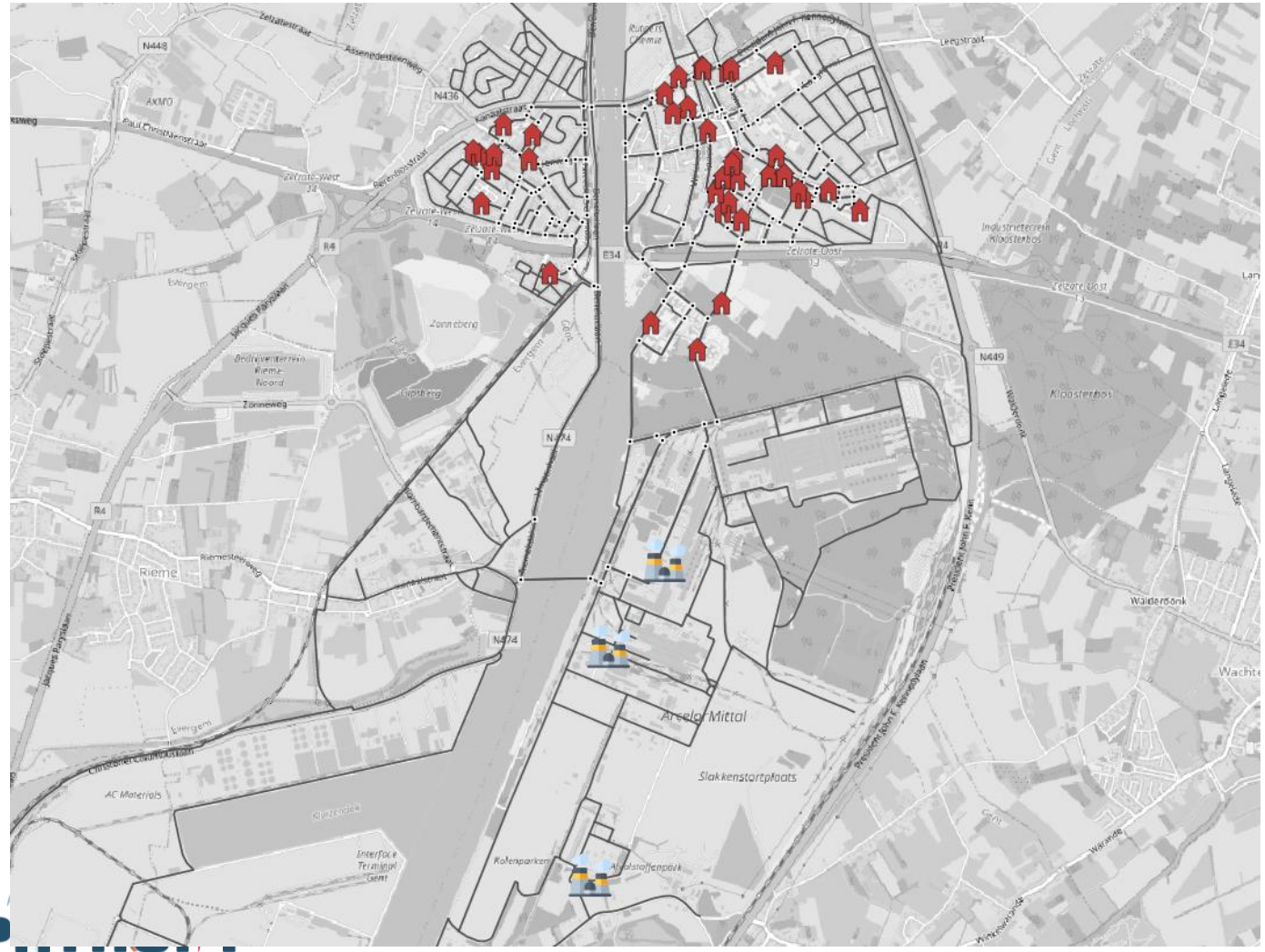
PathOpt – What happened in HURRICANE so far?

- Additional developments
  - Front-end:
    - Improved input processing
    - Additional integration of existing online databases (such as OpenStreetMap…)
  - Back-end:
    - Improved algorithm robustness
    - Including dynamic and temporal behaviour of producers and consumers
    - Ongoing: inclusion of energy storages, coupling to other energy carriers

- Scenario analyses for excess heat delivery of ArcelorMittal Belgium to surrounding municipality of Zelzate, north of the site

PathOpt – inputs



- Possible routing options from OSM
  - Removed: roundabouts, multi-lane road, cul-de-sacs…
  - Added: potential canal crossings, additional options
- Potential consumers for the DH network
  - 27 larger consumers
  - Mostly public buildings
  - 6.2 GWh (~470 eq. households)
  - 2.8 MW peak power
- 3 potential sources of heat
  - Walking beam furnace of the hot rolling mill: 70°C
  - Blast furnace granulation tower: 70-75°C
  - Cokes factory: circa 55°C
  - In total: 6.6 MW available

PathOpt – scenario variation

Scenario variation

2A: right + left bank canal, 100% connectivity

3: only right bank canal , 100% connectivity

4: only left bank canal , 100% connectivity

5: right + left bank canal, 50% connectivity (random)

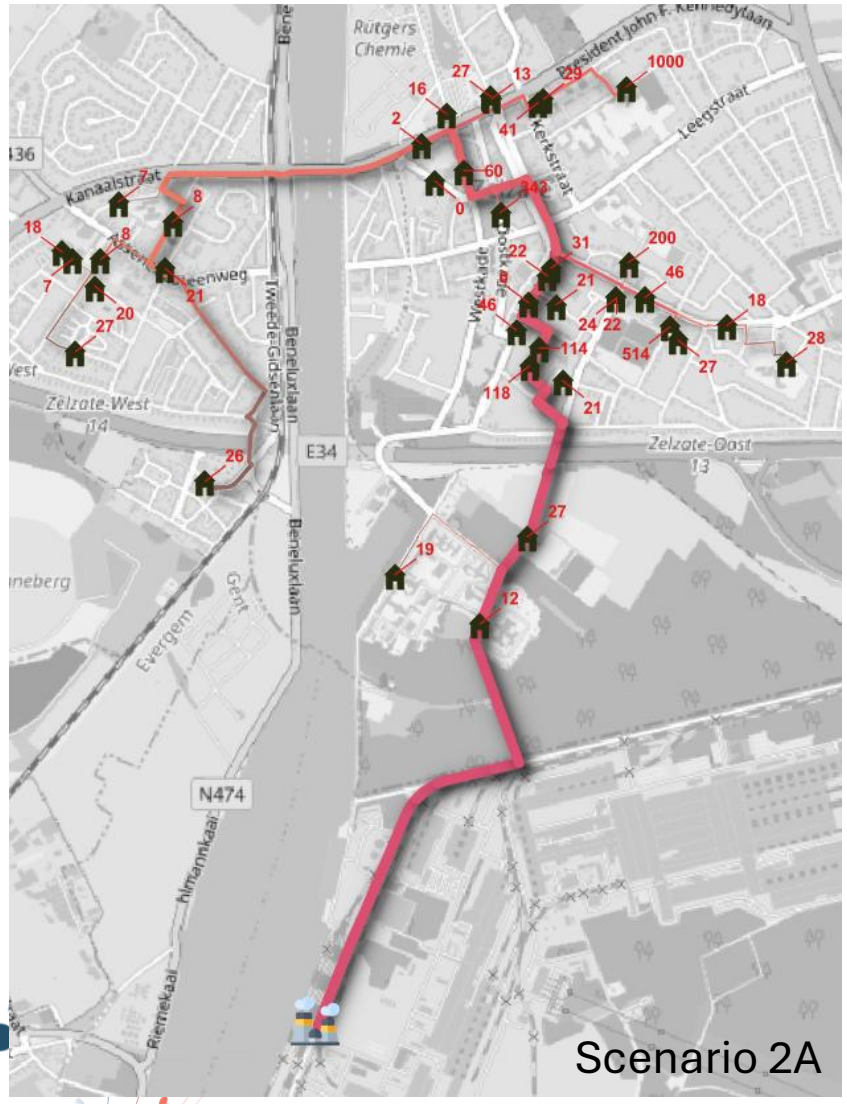
6: incl. STORM – all buildings 20% reduction in peak power

7: incl. STORM – 5 biggest heat consumers 40% reduction in peak power

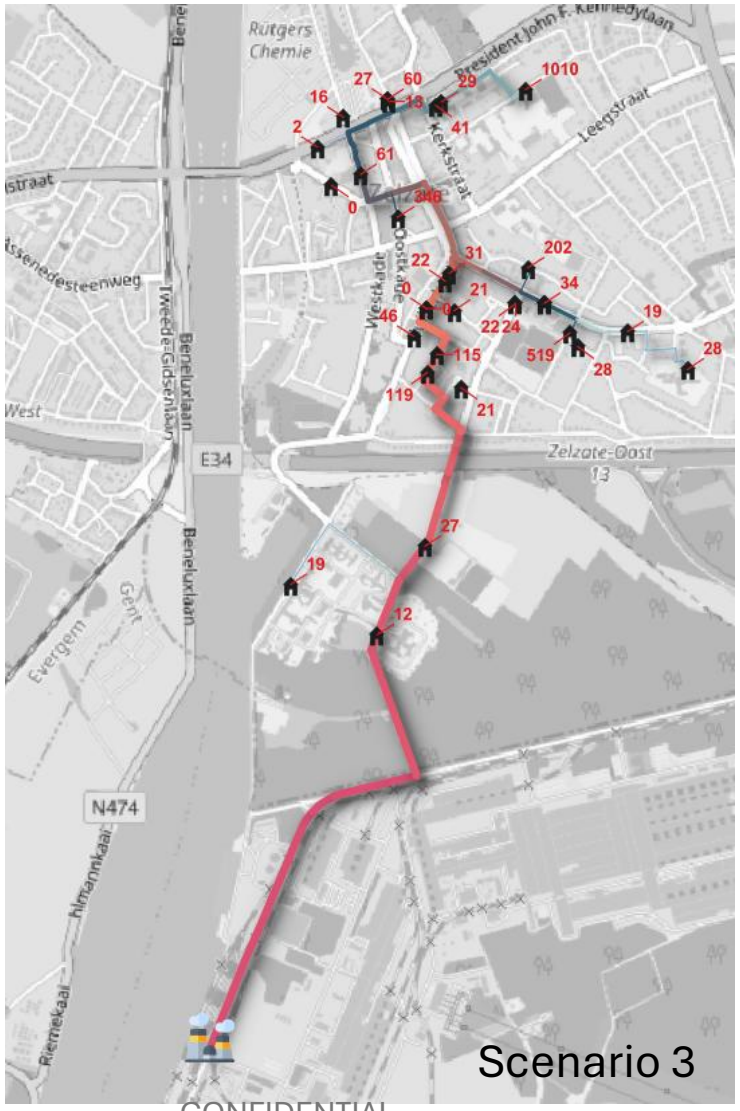
Assumptions

- Default cost of heat: 0.01 ct/kWh
- Heat capex: 300.000 €/MW
- Default cost of electricity: 11 ct/kWh
- Pump capex: 100 €/kWh
- Pipe diameters considered: DN 0 – 32 – 65 – 100 – 150 – 200 – 300 – 400
- Pipe prizes: €/m 0 – 202 – 218 – 258 – 448 – 461 – 665 – 922
- Trenching cost: 400 €/m
- Non-linear model using turbulent flow
- Peak demand dimensioning with 100% thermal demand satisfaction
- Maximum pressure drop allowed: 12 bar
- Supply temperature at producer: 75 °C
- Minimal supply temperature: 60 °C
- Project horizon: 30 years
- IRR: 5%
- **Optimization towards minimal Total Cost of Ownership**

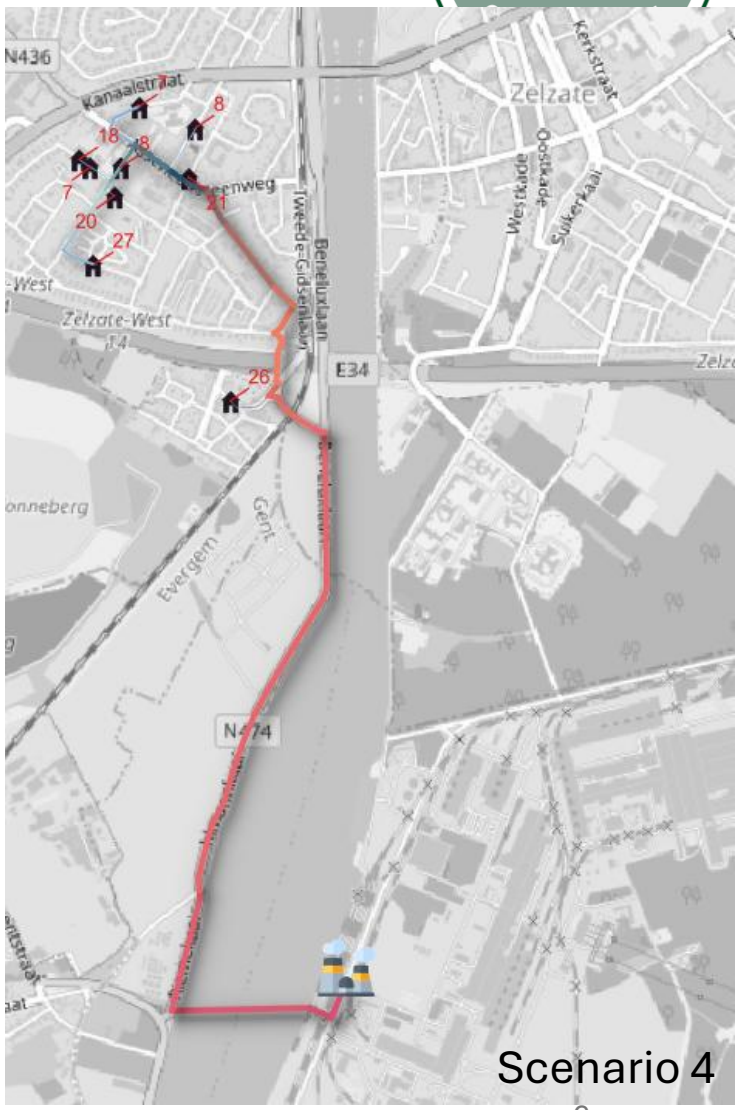
PathOpt – results optimal typology



Scenario 2A



Scenario 3



Scenario 4

PathOpt – conclusions

- PathOpt is a non-linear automatic optimization framework to define optimal DH network typologies (routing + diameters)
- PathOpt was applied in HURRICANE to analyse DH design scenarios for the excess heat of AMB
- 'Left bank only' turns out the cheapest (CAPEX & TCO), then 'right bank only', then 'all' scenario
- 50% heat density reduction increases the minimal heat price by ~25%

- Next steps:
  - Refinement of the assumptions for scenario analyses
  - Assess the effect of peak shaving controllers (such as STORM) on the network design

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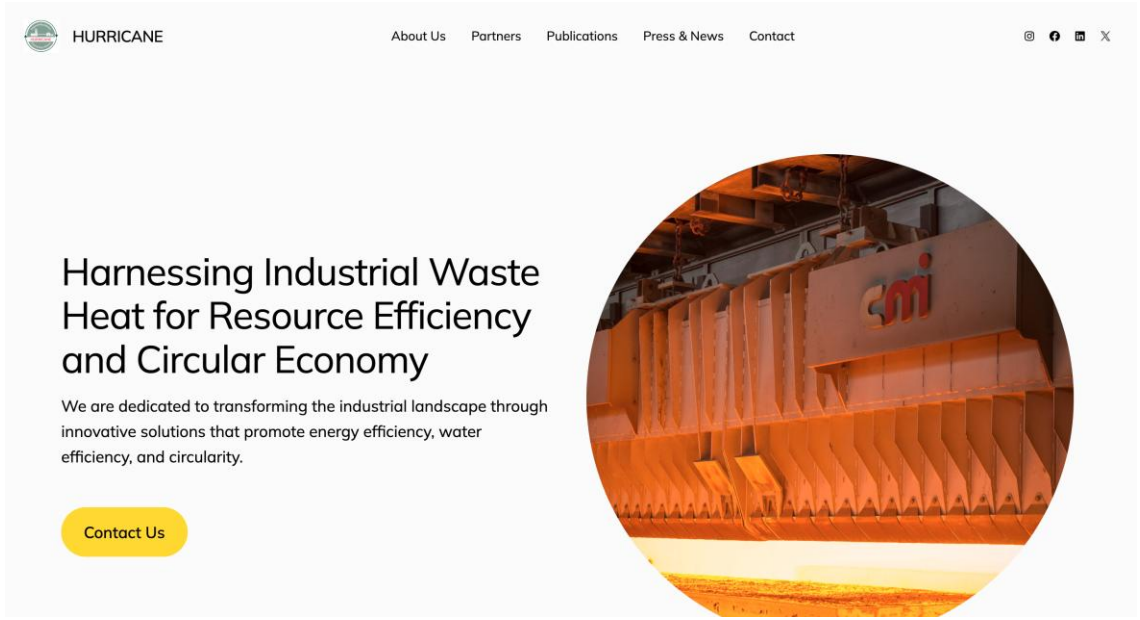

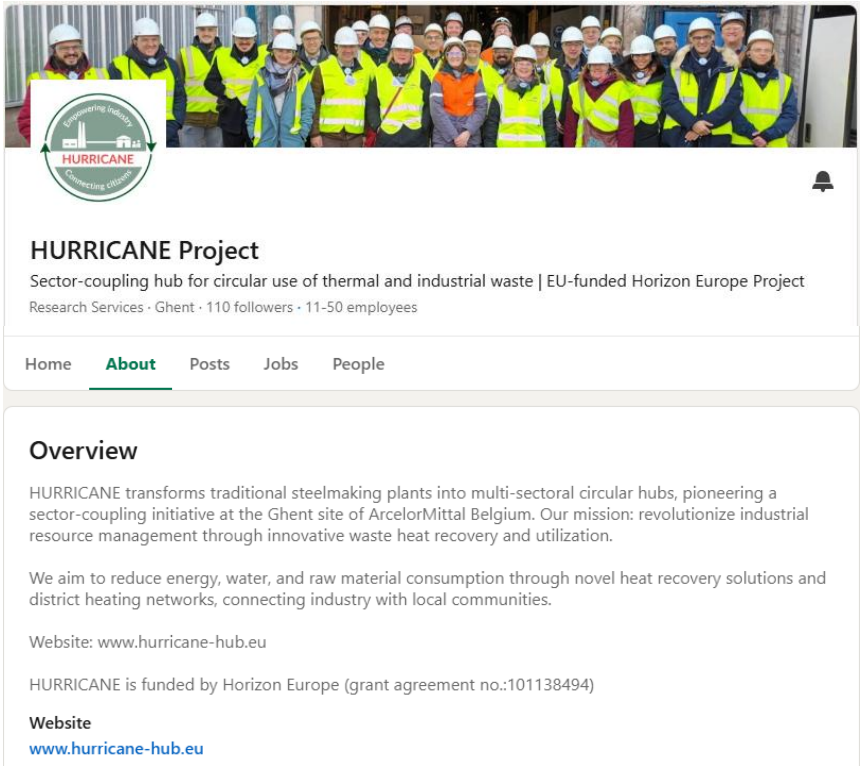

Thank you!

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